ISETC2025

UNIVERSITI TEKNOLOGI MARA

ISETC2025

2 ND INTERNATIONAL SCIENCE, ENGINEERING AND TECHNOLOGY COLLOQUIUM



THE POWER OF SCIENTIFIC INNOVATION

INTELLIGENT SOLUTIONS FOR A SUSTAINABLE WORLD

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PREFACE

Welcome to the 2nd International Science, Engineering and Technology Colloquium 2025 (ISETC 2025)!

It is with great pleasure that we present this year's colloquium, a distinguished gathering of scholars, researchers, and professionals dedicated to the advancement of applied sciences. Held virtually on 9th July 2025, ISETC 2025 serves as a platform to highlight cutting-edge research, foster meaningful networking, encourage collaborations, and explore innovative solutions to global challenges.

This year's theme, "The Power of Scientific Innovation: Intelligent Solutions for a Sustainable World" highlights our shared goal to solve global challenges through applied science. It celebrates innovation as a key to building a more sustainable and resilient future. We're proud to feature keynote speakers and presenters who bring fresh insights, bold ideas, and breakthroughs shaping tomorrow's world.

We would like to extend our heartfelt appreciation to the Faculty of Applied Sciences, Universiti Teknologi MARA, Perak Branch, Tapah Campus, for their outstanding support and assistance throughout the planning and execution of the event. Their dedication has been instrumental to the success of this colloquium. We would like to sincerely thank all participants and researchers for their valuable contributions. We also appreciate the reviewers for their careful evaluations and helpful feedback. Your hard work and support mean a lot to us.

As editors, we are proud to present this collection of proceedings. It is an honour to bring together the interesting and meaningful work of our speakers and authors. We hope the ideas shared will lead to new discoveries, encourage more research, and help solve global challenges through science and innovation.

Warm regards,

Dr. Emi Norzehan Mohamad Mahbob
Dr. Saiyidah Nafisah Hashim
Ms. Lili Widarti Zainuddin
Ms. Nurul Nazwa Mohammad
Ms. Rozaina Saleh

ISETC 2025 Proceedings Editors

PHOTODEGRADATION OF METHYL ORANGE OVER Cu, Co AND Fe DOPED NiO UNDER VISIBLE LIGHT

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Abstract: This study focuses on the photocatalytic degradation of methyl orange (MO) using Cu, Co, and Fe doped nickel oxide (NiO) catalysts synthesized via the precipitation method. Characterization was carried out using Fourier-transform infrared spectroscopy (FTIR) and ultraviolet-visible (UV-Vis) spectroscopy, while further structural analysis is recommended through Raman and X-ray diffraction (XRD) techniques. FTIR results confirmed the formation of Ni-O bonds and identified secondary peaks corresponding to C-O and nitrate residues. The absence of a broad absorption band around 3200–3600 cm^{-1} indicates complete oxide formation with minimal hydroxyl content. However, UV-Vis analysis showed an increase in absorbance under light exposure, suggesting poor photocatalytic performance. This may be attributed to low dopant concentration, neutral pH conditions, and insufficient light intensity. Although the catalysts were successfully synthesized, the overall photocatalytic degradation efficiency remained low. Future improvements should focus on optimizing dopant levels, modifying solution conditions, and confirming doping success via Raman and XRD analysis.

***Keywords*:** *Methyl orange, photodegradation, NiO nanoparticle, precipitation method, visible light*

INTRODUCTION

Methyl orange (MO) is a widely used synthetic azo dye in textile and as a pH indicator, but it poses serious environmental threats due to its toxicity and non-biodegradability (Alves et al., 2025). Photocatalysis is a process that uses light and a catalyst to break down harmful substances. It helps degrade the dye by generating reactive radicals that break methyl orange into harmless compounds like water and carbon dioxide (Huang et al., 2025). Nickel oxide (NiO) has gained attention for photocatalytic applications because of its p-type semiconducting nature, chemical stability, and low environmental impact (Arulkumar & Thanikaikarasan, 2024; Bhattu et al., 2024; Makhado et al., 2024). However, its wide band gap ranging from 3.6 to 4.0 eV, which limits its photocatalytic response to UV light only (Dagar & Narula, 2016) in addition to high photogenerated charge carrier recombination rate. Therefore, researchers have explored modifications such as doping with transition metals to improve its performance in dye degradation (Far et al., 2024). Despite promising progress, further research is needed to develop more effective NiO-based photocatalysts and understand how synthesis conditions influence their performance. This study aims to address these gaps by preparing metal oxide photocatalysts via the precipitation method and evaluating their ability to degrade methyl orange under various conditions. The growing concern over dye pollution and the need for green, low-cost treatment methods make this research both relevant and necessary.

MATERIALS AND METHODS

Materials

The chemicals used in this study include nickel nitrate ($Ni(NO_3)_2$), copper(II) sulphate ($CuSO_4$), cobalt(II) chloride ($CoCl_2$), iron(III) chloride ($FeCl_3$), sodium hydroxide (NaOH), methyl orange dye, distilled water, and hydrogen peroxide (H_2O_2). Equipment used comprises an analytical balance, measuring cylinder, retort stand and burette, test tubes, test tube racks, a furnace, an oven, a magnetic stirrer, and a pestle and mortar. A xenon flash lamp served as the visible light source in the photocatalytic process. Laboratory instruments include Fourier Transform Infrared spectroscopy (FTIR) and UV-Visible spectrophotometry (UV-Vis).

Synthesis of Photocatalysts

First, 3.0 g of nickel nitrate was dissolved in 30 mL of distilled water. NaOH was added dropwise with constant stirring until complete precipitation occurred. The resulting precipitate was filtered and dried in an oven at 100 °C for 24 hours. The dried solid was then ground into a fine powder and calcined at 550 °C for 2 hours in a muffle furnace to form NiO.

Photodegradation of MO

Photocatalytic activity was studied using a 5 ppm methyl orange solution prepared with distilled water. In each trial, 10 mg of the selected catalyst (NiO-CuO) was dispersed in 50 mL of the dye solution. The suspension was stirred continuously for 3 hours. At every 30-minute intervals, 5 mL samples were withdrawn and centrifuged for 6 minutes to separate the solid catalyst from the liquid. The clear supernatant was collected into labelled test tubes and covered with aluminium foil to prevent ambient light interference. Each experiment was also repeated with the addition of 0.1 mL of 30% hydrogen peroxide (H_2O_2) to study its effect on photocatalytic efficiency.

RESULTS AND DISCUSSIONS

FTIR spectra were obtained for pure NiO and doped catalysts (NiO-CuO, NiO-CoO, and NiO-FeO) as showed in Figure 1. All samples showed a distinct peak around 556 cm^{-1}, which corresponds to Ni–O stretching, confirming the formation of nickel oxide (Alagiri et al., 2012; Rahdar et al., 2015). Additionally, the peak observed at 1120 cm^{-1} is identified as C–O stretching vibrations, possibly due to residual carbonate species formed during synthesis (Ahmad et al., 2022). Meanwhile, the absorption at 1358 cm^{-1} is associated with nitrate residues, likely resulting from the incomplete decomposition of nitrate precursors during calcination (Razvan et al., 2024) The absence of broad absorption in the 3200 -3600 cm^{-1} region suggests that hydroxide groups were removed during calcination, indicating successful oxide formation.

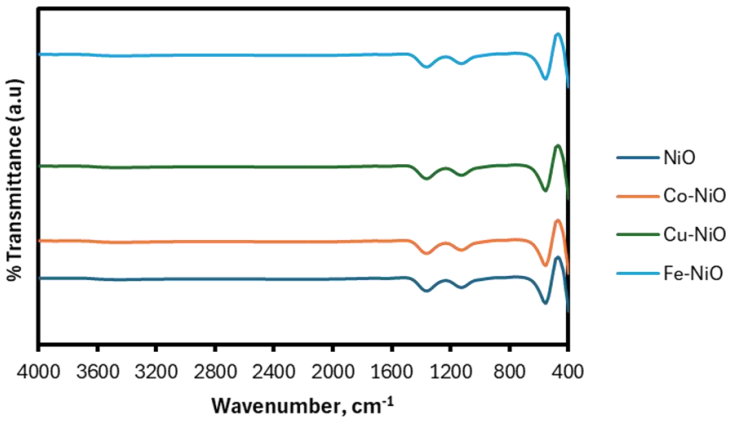


Figure 1. FTIR peak of synthesized photocatalysts

CONCLUSIONS

This study aimed to synthesize and evaluate the photocatalytic activity of Cu-, Fe-, and Co-doped NiO catalysts for the degradation of methyl orange dye. All catalysts were successfully prepared using the precipitation method followed by calcination at 550 °C. FTIR analysis confirmed the formation of Ni–O bonds in all samples, with characteristic absorption at 556 cm^{-1}.

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Sekian, terima kasih.

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Setuju.

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